AIRLINE ENGINEERING AND MAINTENANCE ORGANIZATION

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A THESIS

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by

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AIRLINE ENGINEERING AND MAINTENANCE ORGANIZATION

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EXPLANATION OF TERMS USED

CAA.--The Civil Aeronautics Adminstration (a branch of the Department of Commerce) constructs and operates the Federal system of civil airways, develops air navigation facilities and aviation equipment, promotes airport development, and enforces regulations set up by the CAB.

CAB.--The Civil Aeronautics Board, an independent agency charged with economic regulation of scheduled air carriers, including the supervision of passenger and cargo rates, and fixing of mail rates, the authorization of routes, the establishment of safety standards, and the investigation of accidents to civil aircraft.

Flight Utilization.--The number of hours or miles per plane actually flown.

Load Factor.--The ratio of passenger seats sold to those available. Example: A plane with 20 seats, of which 10 are occupied by revenue passengers, has a 50% Load Factor.

Line Maintenance.--All maintenance activities designed to keep aircraft in a constant state of repair, including, for the purposes of the system proposed in this thesis, engine changes; generally divided into three different check periods in terms of plane hours flown: Turnaround, intermediate, and major.

Overhaul.--Heavy maintenance work required to keep aircraft in a constant state of repair; generally divided into plane and engine, and major overhaul periods, in terms of plane hours flown.

AIRLINE ENGINEERING AND MAINTENANCE ORGANIZATION

CHAPTER I

INTRODUCTION AND THE PLAN OF ORGANIZATION

INTRODUCTION

In this thesis the author presents a system of airline engineering and maintenance organization, applicable to the requirements of any airline operating existing types of transport airplanes, based within the continental limits of the United States. This system is designed to incorporate in its organizational structure the framework of authority and responsibility necessary to operate, control, and maintain an efficient airline engineering and maintenance organization. An efficient organization is deemed to be one that promotes the highest possible degree of flight utilization at the lowest unit cost, while maintaining the necessary high standard of safety.

Information for this work was obtained from two sources. Existing literature was examined to determine the basic principles of industrial engineering and organization applicable to airline engineering and maintenance, and the development of systems currently being used by the airline industry. A survey was conducted to secure information related directly to the proposed system. In the survey existing airline engineering and maintenance organizations were studied, and the various

aspects of the proposed system were discussed with airline representatives and aircraft consulting engineers.

THE PLAN OF ORGANIZATION

The proposed system of airline engineering and maintenance organization is based upon two propositions which concern the airline industry as a whole. The success of the system of organization for a single airline, as presented in this work, will depend upon the adoption of these propositions by all the airlines. Therefore, it is necessary to discuss the basic propositions of the system affecting the entire industry before actual presentation of the proposed system of engineering and maintenance organization.

The first basic proposition for the airline industry is to discontinue the policy of individually performing all major airplane and engine overhaul work, and to schedule all overhaul work to be done by an outside organization. Adoption of this plan by the industry would benefit each airline in the following ways:

1. Outside concerns, with full and carefully supervised production lines in constant operation, can perform airplane and engine overhauls faster, better, and with lower unit costs than the airlines can do it themselves. With the entire industry participating in the plan, these outside concerns would be able to cut unit overhaul costs as compared with the cost

when the work is done by the individual airlines.

2. The airlines would not be faced with the problem of the tremendous investments involved in expanding overhaul facilities when they expand their fleets of airplanes. The purchase of new airplanes of larger size with new design features would not necessitate the expansion of overhaul hanger space and tooling facilities.
3. Personnel would not have to be trained in the new procedures and methods required to overhaul new airplane and engine types.
4. The necessity for standby airplanes to continue operations while others were undergoing overhaul would be eliminated. When airplanes required overhaul they would be scheduled for overhaul, flown to the overhaul plant, and an airplane from the pool of overhauled aircraft at the plant flown out ready for immediate service. This system would increase the flight utilization of the fleet, and, therefore, the revenue plane miles flown.
5. With the savings in time and money resulting from scheduling overhauls by an outside concern, the airline would have the opportunity to develop, expand and improve other phases of engineering

and maintenance. In particular, more attention could be directed towards engineering and maintenance activities with the object of promoting safety, decreasing costs, and improving the airline service in general.

The second basic proposition for the airline industry is to pool their facilities in a coordinated system of line maintenance at the terminals. Adoption of this proposition by the industry would benefit the airlines in the following ways:

1. To discontinue the relatively wasteful practice of duplicating facilities in favor of cooperative activities in line maintenance at the terminals would mean reduced operating costs and investment charges. In particular, there would be considerable savings in required ground equipment and line maintenance personnel.
2. A coordinated system of line maintenance at the terminals would make for more efficient operation. More ground space would be available with the result that any given terminal could accommodate a larger number of airplanes. A central control system, operating on behalf of all the airlines using the terminal, could control all line maintenance activities in an efficient manner,

with a minimum of confusion.

3. By combining line maintenance activities at the terminals the airlines would be able to install a production line system to handle intermediate and major line checks. This sytem would reduce costs and make faster checks possible. Operating the system as a functional organization, better inspections would be possible, thereby promoting safety.
4. A coordinated terminal system would provide better passenger service. Ground services, delays, and the regularity of flights would be improved considerably.
5. With the savings resulting from the adoption of the proposition the airlines would be able to contribute to a program designed to improve passenger facilities at the terminals.

The following system of airline engineering and maintenance organization, applicable to the requirements of a single airline, is predicated upon the adoption of these two basic propositions for the airline industry. This system represents the organizational structure necessary for a single airline to operate according to the basic propositions, and to maintain an efficient Engineering and Maintenance Division.

CHAPTER II

THE SYSTEM OF ORGANIZATION

DIVISION ORGANIZATION

The proposed system of organization for the Engineering and Maintenance Division is shown on the Master Organization Charts, Figures 1, 2, and 3. The organization is built around functions with a line and staff framework of authority and responsibility. Each department, section, unit, and group of the Division is organized on the basis of the function performed. Modifications may be introduced by any individual airline to insure the performance of the particular functions delegated to each component of the organization. However, since the system is built around functions, and not individuals, the modifications can be restricted to the personnel required by any particular division of the organization.

As shown on the Master Organization Charts, the Engineering and Maintenance Division is divided into two main departments, Engineering and Maintenance. These Departments are further divided into Sections, Units, and Groups. An effort has been made to adopt standardized terminology for the major organizational components.[1]

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[1] Rowland, Floyd H., "The Plan of Organization," Advanced Management Quarterly Journal, Vol. II, No. 4, p. 161.

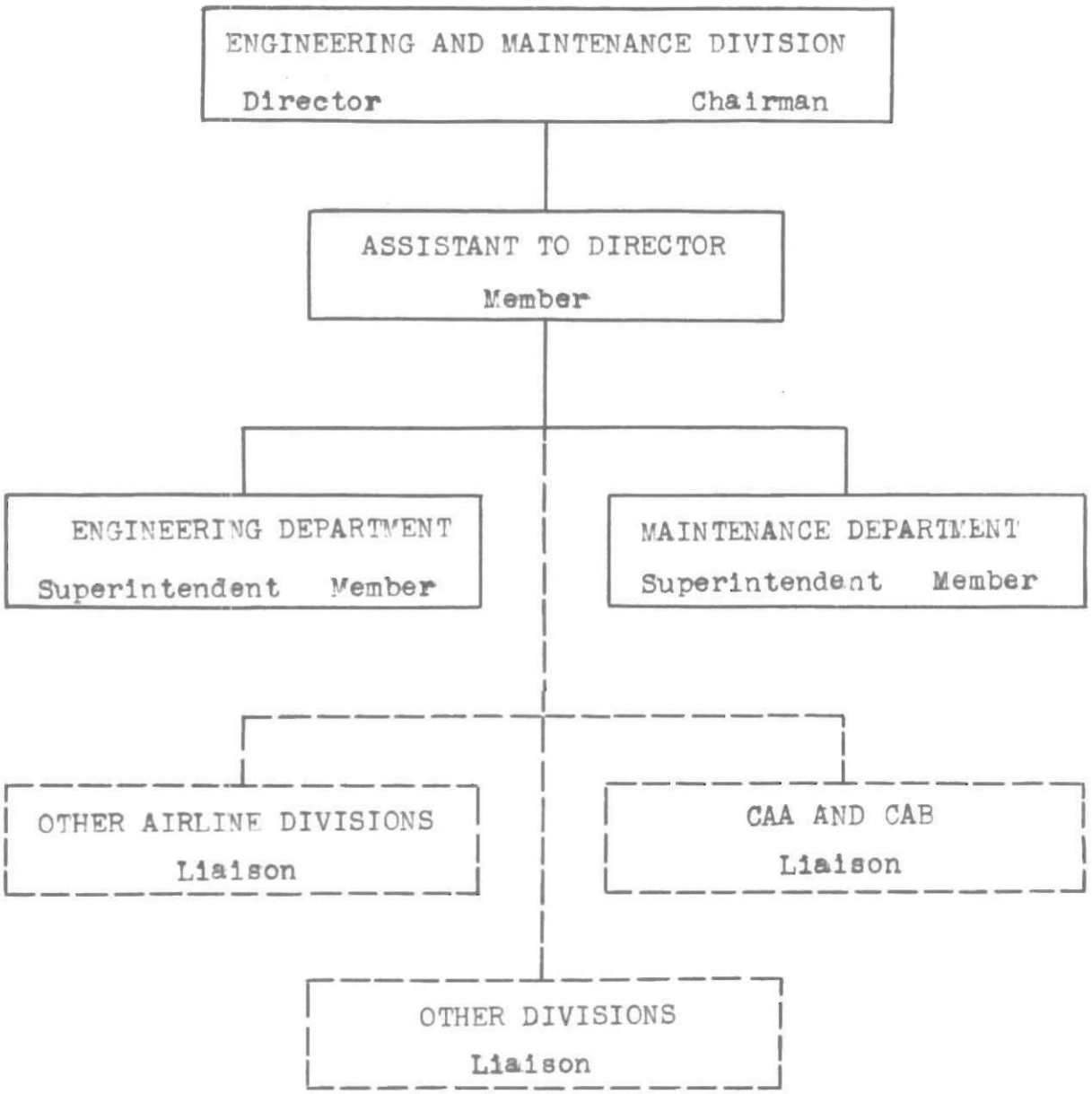
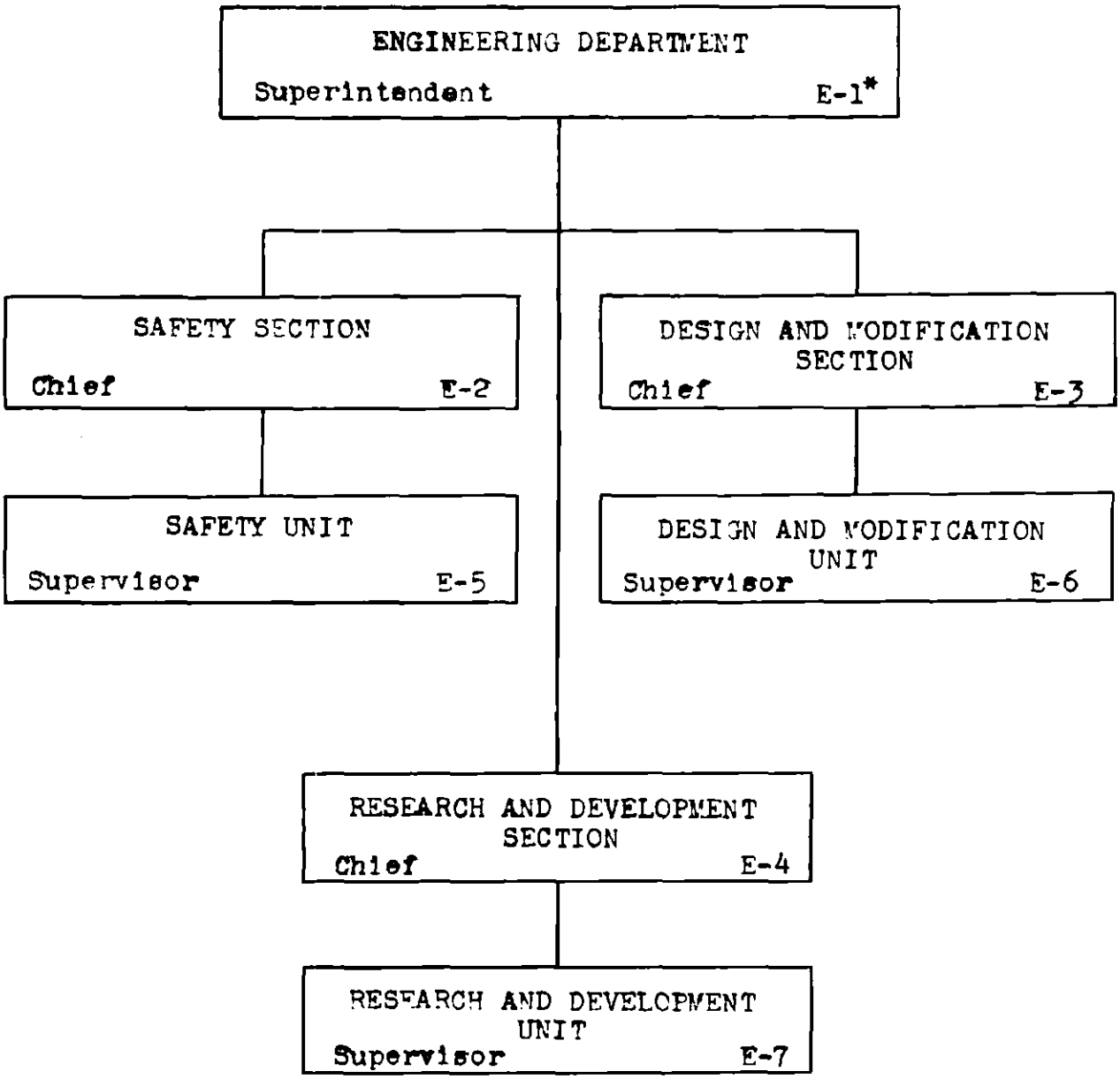


Figure 1.—Master Organization Chart of the Staff, Engineering and Maintenance Division.



*Key number assigned to individual holding position. This system does not necessitate chart revision every time a change in personnel takes place.

Figure 2.—Master Organization Chart of the Engineering Department.

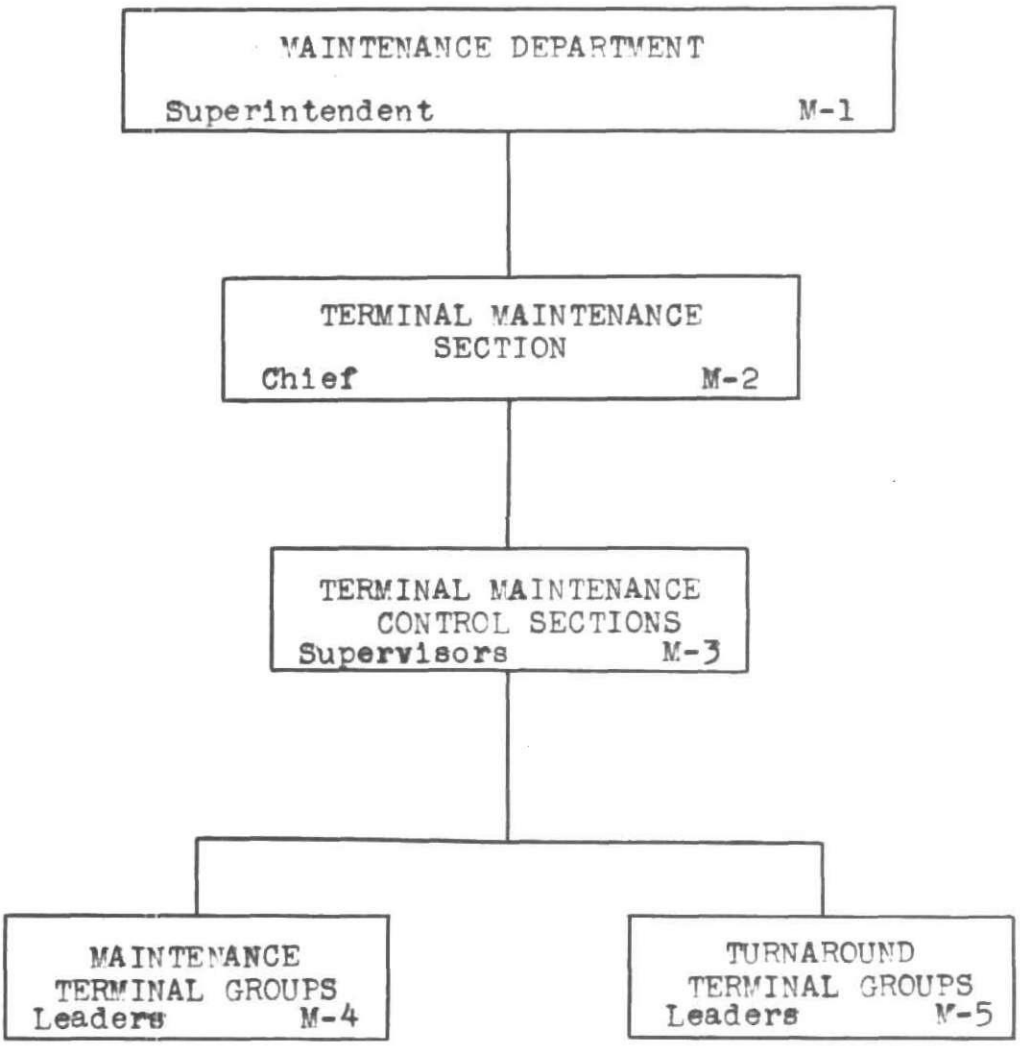


Figure 3.—Master Organization Chart of the Maintenance Department.

THE DIVISION STAFF

The Staff of the Engineering and Maintenance Division includes the Director of the Division, the Assistant to the Director, and the Superintendents of the Engineering and Maintenance Departments. With the Director acting as Chairman, the Staff acts together as a committee to supervise and coordinate the activities of the Division. As each member of the Staff is the head of a major component of the Division organization, the Staff is not set apart from the activities of the Division, but is in a position to perform the required functions in an efficient manner and to promote immediate action on Staff decisions and directives.

The organization of the Staff and liaison with outside organizations is shown on the Staff Organization Chart, Figure 1. The Staff has the following specific functions:

1. The execution of company policies within the Engineering and Maintenance Division.
2. The coordination of all functions and activities of the Engineering and Maintenance Division.
3. The coordination of Engineering and Maintenance Division activities with other company divisions.
4. The maintenance of liaison between the Division and the CAA.
5. The coordination of all Line Maintenance activities of the Division with those of other airlines.

DUTIES AND RESPONSIBILITIES

In the following outline are the duties and responsibilities delegated to each position in the Engineering and Maintenance Division:

I. Director of Engineering and Maintenance.

1. Responsible to the Vice President of Operations.
2. Acts as Chairman of the Staff-Committee.
3. Responsible for the conduct and efficiency of all Division personnel.
4. Coordination of all interdepartmental activities and the execution of company policies within the Engineering and Maintenance Division.
5. Coordination of Engineering and Maintenance functions and activities with the other staff divisions.

II. Assistant to the Director of Engineering and Maintenance.

1. Responsible to the Director of Engineering and Maintenance.
2. Assists the Director in the administration and coordination of all divisional activities,

and the execution of company policies within the Engineering and Maintenance Division.

3. In the absence of the Director, he is responsible for the administration and coordination of all divisional activities and the execution of company policies within the Division, and with other divisions.

III. Superintendent of the Engineering Department.

1. Responsible to the Director of Engineering and Maintenance.
2. Responsible for the efficiency and conduct of all personnel within the Engineering Department.
3. Responsible for the administration of all departmental activities and the execution of company policies within the Engineering Department.
4. Responsible for the maintenance of a Master Control and Progress Chart of all engineering projects.

IV. Safety Section Chief.

1. Responsible to the Superintendent of the Engineering Department.
2. Responsible for coordinating and acting as an advisor on all the functions of the Section.

3. Responsible for the compilation and distribution of the following reports and records:
    a. Accident Reports.
    b. Monthly Service Trouble Reports.
    c. Monthly CAA Reports.
    d. Delay and Trip Interruption Reports.
    e. CAA Form 478 Reports.
    f. Aircraft Log Forms.
    g. Inspection Forms.
    h. Historical Aircraft Records.
4. Responsible for the review of all Accident Reports, Monthly Service Trouble Reports, and Delay and Trip Interruption Reports.
5. Responsible for compiling and issuing Division ground, building, and aircraft safety bulletins.
6. Responsible for coordinating the activities of the Safety Section with those of the Research and Development Section.

V. Safety Unit Supervisor.

1. Responsible to the Safety Section Chief.
2. Responsible for all building and ground safety engineering.
3. Maintains liaison with CAA Safety Engineering.

4. Responsible for the distribution of the following material to the Engineering and Maintenance Division:
    a. Division Safety Bulletins.
    b. CAA Airworthiness Directives.
    c. CAA Mandatory Notes.
    d. Aircraft Specifications.
    e. Manufacturer's Service Bulletins.
    f. All Maintenance Magazines.
5. Responsible for maintenance and supervision of a weight and balance control system.

VI. Research and Development Section Chief.

1. Responsible to the Superintendent of Engineering.
2. Responsible for acting as an advisor on all activities of the Section and coordinating the functions of the Section.
3. Responsible for compiling and maintaining permanent records and progress records of all Research and Development projects.
4. Responsible for coordinating the activities of the Research and Development Section with those of the Safety Section.

VII. Research and Development Unit Supervisor.

1. Responsible to the Research and Development Section Chief.
2. Assists the Section Chief in the administration and coordination of all Research and Development projects.

VIII. Design and Modification Section Chief.

1. Responsible to the Superintendent of the Engineering Department.
2. Serves as an advisor and coordinator of all the activities of the Section.
3. Responsible for maintaining a company drafting system.
4. Maintains liaison between the manufacturers and the Section on all matters pertaining to aircraft modification and changes in design.
5. Responsible for the maintenance of all design projects of the company.

IX. Design and Modification Unit Supervisor.

1. Responsible to the Design and Modification Section Chief.
2. Supervises all Design and Modification projects.

3. Serves as an Assistant to the Section Chief in the conduct of Section activities.
4. Responsible for maintenance of a Specification File of all company aircraft and equipment.

X. Superintendent of the Maintenance Department.

1. Responsible to the Director of the Engineering and Maintenance Division.
2. Responsible for the efficiency and conduct of all personnel within the Maintenance Department.
3. Responsible for the administration of all departmental activities and the execution of company policies within the Maintenance Department.
4. Responsible for the maintenance of a Master Control and Progress Chart of all maintenance activities.
5. Maintains liaison between the Maintenance Department and other airline maintenance departments.

XI. Terminal Maintenance Section Chief.

1. Responsible to the Superintendent of the Maintenance Department.
2. Responsible for coordinating the activities of the Terminal Maintenance Control Units.

3. Responsible for maintaining a Master Control Chart of all company aircraft.
4. Responsible for maintaining and coordinating an aircraft and engine overhaul scheduling system.

XII. Terminal Maintenance Control Unit Supervisors.

1. Responsible to the Terminal Maintenance Section Chief.
2. Responsible for the direction of the activities of the Maintenance Terminal Groups and the Turnaround Terminal Groups.
3. Responsible for the conduct and efficiency of all personnel in the Maintenance and Turnaround Terminal Groups.
4. Responsible for maintaining a Maintenance Control System.
5. Responsible for maintaining a Maintenance Records System.

XIII. Maintenance Terminal Group Leaders.

1. Responsible to the Terminal Maintenance Control Unit Supervisors.
2. Responsible for the performance of all Maintenance Terminal activities as directed by the Maintenance Control Units.

3. Responsible for the efficiency and conduct of all personnel within their respective work groups.

XIV. Turnaround Terminal Group Leaders.

1. Responsible to the Terminal Maintenance Control Unit Supervisors.
2. Responsible for the performance of all Turnaround Terminal activities as directed by the Maintenance Control Units.
3. Responsible for the efficiency and conduct of all personnel within their respective work groups.

CHAPTER III

FUNCTIONS OF THE DEPARTMENTS

ENGINEERING DEPARTMENT

One of the many advantages offered by the proposed system of organization is an expanded Engineering Department. In the opinion of the author, the airlines can do much to improve their services and, therefore, better their competitive standing in the field of transportation by increased efficiency in their engineering organizations.

The Engineering Department is divided into three Sections: Safety, Design and Modification, and Research and Development. These three Sections perform all the engineering functions of the Department. While each Section has its own specific functions, the work of the entire Engineering Department is coordinated through the Superintendent of Engineering and the three Section Chiefs. This policy insures the maintenance of an efficient organization in that it promotes a free interchange of ideas and results developed in any of the Sections. It is also possible to coordinate the work of two or more Sections if it is required in the development of a particular project for the department.

In the following the justification of each Section is discussed and the specific functions outlined.

Safety Section.--One of the foremost objectives of any airline is to maintain a perfect safety record. Airline safety is considered so important by the Government that special organizations, the CAA and CAB, have been formed to control and supervise airline activities. Airlines are required to operate under safety regulations setup by the CAB, and enforced by the CAA. Not only is safety important to the airlines from the government regulation standpoint; it is more important to maintain high safety standards in order to cultivate the good will of the public and to cut operating expenses. An airline accident involving the death of passengers causes permanent damage to the safety record. There is the loss to the airline of valuable equipment and personnel besides the immediate loss of revenue reflected in the form of decreased load factors. It has been estimated that a widely publicized airline accident within the continental limits of the United States causes a fifteen percent decrease in load factors, reflected over the entire industry.

Thus it is seen that the Safety Section is a vital element of the airline organization, its prime function being the promotion of flight safety. To accomplish this the Section should perform the following specific functions:

1. Conduct research jointly with the Research and Development Section in flight safety engineering.
2. Maintain and inspect all terminal building and ground safety procedures and equipment.

3. Investigate and evaluate safety procedures and equipment developed by sources outside the airline.
4. Maintain complete record of all airline activities with regard to safety.
5. Compile and distribute to all airline personnel all available information regarding safety.
6. Conduct and supervise personnel safety training programs.
7. Maintain Line Maintenance inspection system.
8. Review all Accident Reports, Monthly Service Trouble Reports, and Delay and Trip Interruption Reports with the object of perfecting preventive safety methods and procedures.
9. Maintain and supervise the weight and balance control system.
10. Maintain constant inspection of airline procedures and methods to insure compliance with CAA and CAB safety regulations.

Design and Modification Section.--The fact that there never has been a transport airplane built that did not require modification of some description, in spite of all the care exercised by the aircraft manufacturers, indicates the functions performed by the Design and Modification Section. The airlines are constantly confronted with the problem of modifying existing designs of airplanes and associated

equipment and preparing new designs adapted to their requirements. These design problems are generally limited to various detail design changes found necessary to improve original equipment and better adapt it to the required service. It is the function of the Design and Modification Section to submit preliminary designs and specifications to the manufacturers for equipment before actual design and construction is begun as well as the modification of existing designs. The airlines have the experience gained from extended service of equipment that is not available to the manufacturers, even after comprehensive flight tests. Thus the airlines are in the best position to know what they need in the way of airplanes and equipment that will satisfy their requirements.

It can be seen, therefore, that the functions of the Design and Modification Section are a major part of the activities of the Engineering Department. Through the efficient operation of this Section, the airline will benefit in the improved service received from aircraft and equipment, the net result being a reduction in operating expense.

The work of the Design and Modification Section is described in the following specific functions:

1. Prepare the preliminary designs and specifications necessary in the purchase of new aircraft and equipment.
2. Conduct the design and engineering work required in the modification of existing aircraft and equipment.

3. Perform the design work required by the airline to construct or modify buildings and equipment.
4. Perform the drafting required by any division of the airline.
5. Maintain a complete file of the specifications and designs of all airline aircraft and equipment.
6. Conduct research jointly with the Research and Development Section with the object of improving existing designs of aircraft and equipment.

Research and Development Section.--Once the airlines have established a safe and efficient service, they must then endeavor to keep abreast or ahead of the field by the constant improvement of their services. Only by constant research and development, dedicated to the improvement of their services, can the airlines stay ahead in this age of rapidly improving transportation. Since the airlines are engaged in selling a public service and not a product, their activities are subject to considerable criticism from the customers, and to regulation by the Government. Thus, they cannot afford not to do everything in their power to maintain a service that is beyond criticism, and subject to as little regulation as possible. The functions of the Research and Development Section are, in general, directed towards the improvement of airline services.

The specific functions of the Research and Development Section are as follows:

1. Research in all phases of airline safety engineering.

2. Development of methods and facilities necessary to improve passenger services.
3. Application of sound Industrial Engineering principles and practices to all airline functions.
4. Research and Development designed to improve existing types of equipment and to originate new and better designs.

The importance of maintaining safety in all airline activities was emphasized in the description of the functions of the Safety Section. The Research and Development Section, conducting research and development work jointly with the Safety Section, can play a major part in the safety program. This is by far the most important function of the Research and Development Section.

Passenger Service is a subject of considerable importance to the airlines. Potential passengers and freight loads are the prime sources of revenue, and anything that can be developed to improve the service rendered these sources will undoubtedly benefit the airlines. The quality and quantity of the services rendered by the airlines are the main factors considered by the public which the airlines hope to serve. Therefore, this phase of research and development work will be widely appreciated and will receive universal praise. Recognizing the need for considerable improvement in passenger services, this function of the Research and Development Section should receive particular attention.

The application of sound Industrial Engineering principles and practices to airline activities has many benefits to offer the airlines.

The development of improved materials handling methods, work methods, and control systems are only a few of the many phases of Industrial Engineering that may be successfully applied to airline activities. Through this function the Research and Development Section can provide the means for getting more work done, in a more efficient manner and in less time, without an increase in costs. Mr. W. P. Hoare, Manager, Cheyenne Maintenance Base of United Airlines had this to say with regard to the advantages of applied Industrial Engineering principles: "Recently we established Production Planning and Work Methods Analysis Departments. As a result we are getting more work done with no increase in shop manhours."[2] It is the function of the Research and Development Section to develop the methods and procedures of Industrial Engineering that can be applied to airline activities. There is no limit to the work that can be done in this direction that will definitely benefit the airlines. Its applications are not limited to engineering and maintenance activities, but may be successfully applied to any division of the airline.

It was emphasized in the discussion of the functions of the Design and Modification Section that it was of major importance to conduct research in the field of equipment design. By constantly striving to improve existing designs and originate new and better designs, the

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[2] Hoare, W. P., Comments on "Overhaul Procedures" by J. F. Nycum, Air Transport Magazine, McGraw-Hill, Vol. 4, No. 8, August 1946, p. 39.

Research and Development Section, working jointly with the Design and Modification Section, will be able to insure the airline the use of equipment better suited to its requirements.

MAINTENANCE DEPARTMENT

The basic proposition for maintenance in the airline industry was presented in Chapter I. This proposition involves the agreement by the airlines, operating within the same sections of the country, to pool their maintenance facilities in a co-operative system. Through this system the airlines can decide upon suitable locations for Maintenance Terminals and Turnaround Terminals, fully utilizing existing facilities, and divide all the required maintenance work of the airlines operating in that section of the country among the various Terminal Groups. Major and intermediate line maintenance, including engine changes, can be done at the Maintenance Terminals. Routine in-route line checks can be handled at the Turnaround Terminals. All work at the Maintenance Terminals can be performed on a co-operative basis, and as far as possible at the Turnaround Terminals. Where only one airline operates over a given route, it will have to independently maintain the necessary Turnaround Terminals. As the work done at these points will be relatively simple this will not be a difficult undertaking. In fact, all the airlines are at present performing their routine checks at the terminals, so it will entail no change of procedures at terminals where the co-operative system cannot be employed.

The general function of the Maintenance Department of any airline is to perform all maintenance activities required by the airline, according to the basic plan. This general function is carried out by the Terminal Maintenance Section, the Terminal Maintenance Control Units,

and the Maintenance Turnaround Terminal Groups. These divisions, through their specific functions described in the following paragraphs, maintain the airline maintenance system.

Terminal Maintenance Section.--Upon this Section is placed the responsibility of conducting and supervising all maintenance activities of the airline. The Section should be located centrally in the system, if possible, in order to facilitate control over the maintenance activities at the various terminals. While the actual maintenance work required by all the airlines in a particular section will be performed on a co-operative basis, the aircraft of each airline will be controlled independently by the Terminal Maintenance Section. This Section is responsible for promoting the highest possible degree of flight utilization of company aircraft through efficient planning and control over maintenance and overhaul. This will be accomplished through the following specific functions:

1. Maintain a Master Control Chart[3] of all company aircraft.
2. Schedule and arrange for all aircraft and engine overhauls by the overhaul contractors.
3. Maintain complete record of all company maintenance activities.
4. Schedule and arrange for all aircraft maintenance work through Terminal Maintenance Control Units.
5. Furnish the Engineering Department with complete statistical maintenance data.

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[3]Explained in Appendix A.

Terminal Maintenance Control Units.--At each Maintenance Terminal all line maintenance and engine changes will be controlled and supervised by a Terminal Maintenance Control Unit. While it is the function of the Terminal Maintenance Control Section to control the maintenance of aircraft owned by a particular company, actual control of maintenance work for a number of airlines at each Maintenance Terminal is handled by a Terminal Maintenance Control Unit. The Terminal Maintenance Control Unit can direct an efficient system of aircraft and engine maintenance which will insure the airlines maximum flight utilization at minimum unit costs. This is possible because each terminal will handle a sufficient number of aircraft to permit the use of a specialized mass production system. Through proper control maintenance work can be performed in less time. These advantages of the system will be realized with no sacrifice of quality, for with efficient control thorough inspections can be enforced.

The Control Unit is responsible for performing all maintenance work assigned by the various Control Sections of the individual airlines to the Maintenance Terminal. The Control Unit has the following specific functions:

1. Maintain a Master Control Chart of all maintenance activities at the terminal.
2. Route, schedule, dispatch, and follow-up all required maintenance work at the terminal.
3. Keep a complete record of all maintenance activities at the terminal.

4. Maintain the Terminal Ramp Control System.[4]

5. Maintain liaison between all airline Terminal Maintenance Sections and the Terminal Maintenance Control Unit.

Maintenance Terminal Groups.--These Groups will perform the actual maintenance work at the Maintenance Terminals as directed by the Terminal Maintenance Control Units. Under the supervision of the Group Leaders, a production line system can be setup to accommodate all maintenance work. Besides performing all regular maintenance work, these Groups will also handle emergency maintenance assignments, and any other functions specified by the Control Units.

Turnaround Terminal Groups.--It is the function of these work groups to perform all routine in-route line checks at the Turnaround Terminals as directed by the Control Units.

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[4]Organization and explanation in Appendix B.

CHAPTER IV

DISCUSSION AND CONCLUSIONS

DISCUSSION

After a thorough examination of the system of Airline Engineering and Maintenance Organization presented in this work, the reader might reasonably ask why such a system has not been adopted by the airline industry. The answer to this question can be found in the following discussion of the problems facing the airlines. These, and other connected problems must be solved before there can be any hope of the universal adoption of the proposed system. It is the opinion of the author that these problems may be readily solved through the coordinated efforts of the airlines. Possible solutions are included in the following discussion.

One of the foremost objections voiced by the airlines involves the question of competition. They argue that a coordinated system of "Airline Engineering and Maintenance Organization," as proposed herein, would destroy all the benefits derived through friendly competition between the airlines. The loss of the advancements in service quality as a result of independent operations is particularly emphasized. However, upon further consideration it is seen that this problem is not beyond solution. In the first place, the fact that the competition offered by other transportation services is of foremost importance, should not be overlooked. It is this competition that the airlines

should consider before they denounce the proposed system. It is of little importance to maintain competition within the industry at the present level if, through the adoption of the proposed system, the airlines will be in a better position to offer a service that will be a greater challenge to other means of transportation. The proposed system of Airline Engineering and Maintenance Organization is not designed to benefit the industry at the expense of competition between the airlines. On the contrary, it is designed to maintain and expand individual airline activities that will insure a continuous advancement in service standards. The system provides expanded engineering functions, through which the airlines can develop their individual service standards, and at the same time maintain an industry-wide transportation service that can successfully compete with other means of transportation.

Another problem is to decide where the airplane and engine overhaul work will be performed. The logical answer is to have the aircraft and engine manufacturers handle this function. They have adequate facilities and experience in production line techniques that would be difficult to equal elsewhere. The arrangement that Eastern Air Lines, Incorporated has with the Glenn L. Martin Aircraft Corporation[1] provides a good example of how overhauls might be handled. This arrangement provides for a fleet of standby airplanes, maintained by the Martin Corporation. Whenever an airplane is ready for overhaul it is flown to the plant and a standby

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[1]"Standby Planes," Business Week, McGraw-Hill, No. 848, December 1, 1945, p. 20.

airplane flown out ready for immediate service. Through this system it is possible to keep a constant number of aircraft in service at all times. This arrangement will require the airlines to purchase more aircraft, but it should not necessarily increase operation costs. The manufacturer will sell more airplanes and therefore be able to produce them at a lower unit cost to the airlines. Also, the increase in flight utilization possible through the operation of such a system would insure increased revenue. If the manufacturer is located in a section of the country which is not convenient to a particular airline other arrangements must be made. Either the manufacturer must be convinced that there is enough business to warrant the establishment of a branch plant at a convenient location, or overhaul work accomplished through a contract with a local overhaul company. There are several overhaul organizations with branches all over the country qualified to perform overhaul work utilizing production line methods. Pacific Airmotive Corporation, for example, has engine overhaul plants at the following locations: Phoenix, Arizona; Burbank, California; Oakland, California; San Diego, California; Glendale, California; Fresno, California; Linden, New Jersey; Kansas City, Missouri; Seattle, Washington; and Anchorage, Alaska.[2]

Probably the most difficult problem that must be solved before a co-operative system of maintenance can be adopted is the standardization

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[2]Bangs, Scholer, "Pacific Airmotive Working Towards Pooled Maintenance," Aviation News, McGraw-Hill, April 21, 1947, Vol. 7, No. 16, p. 16.

of airline maintenance requirements. A recent tabulation of the frequency of overhaul and maintenance of airplane accessories,[3] as performed by a number of different airlines, indicated a large range of variation. This is a result of independent decisions reached by each airline as to the required frequency of maintenance and overhaul work on accessories, and the approval of these individual requirements by the CAA. Not only does this wide variation exist in accessory maintenance and overhaul, but in the frequency of airplane and engine maintenance and overhaul check periods as well. If any degree of efficiency is to be obtained through co-operative maintenance and overhaul activities, as specified in the proposed system of Airline Engineering and Maintenance Organization, an effort must be made to standardize the requirements of the airlines. One possible solution is to divide the equipment into two groups: (1) that used on long non-stop flights, and (2) that used on relatively short flights with frequent stops. The requirements of these two groups seem to be the greatest cause for the wide variations. Then it might be possible to standardize the entire maintenance and overhaul requirements of these two groups, respectively. It would not be necessary to set identical standards for each airline, but it would be necessary to improve present conditions. This could only be accomplished through the coordinated efforts of the airlines and the CAA.

The problems discussed are not the only ones requiring solution

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[3] Herrick, George, "Life Expectancy Of An Accessory," Air Transport Magazine, Vol. 4, No. 8, August 1946, p. 62.

before the airline industry can adopt the proposed system of Airline Engineering and Maintenance Organization, but it is believed that they are the ones of major importance. Numerous problems will undoubtedly present themselves when such a change in existing organizations is made. It is encouraging to note that the few phases of the proposed system that have actually been tried have been successful.

CONCLUSIONS

The proposed system of Airline Engineering and Maintenance Organization, based upon two basic propositions for the airline industry, is applicable to the requirements of any airline operating existing types of transport airplanes. While any single airline could benefit from the use of particular phases of the system, the success of the entire system of organization will depend upon the adoption of the basic propositions by the airline industry. Through the coordinated efforts of the airlines and the CAA, the problems involved in changing existing organizations can be solved. Adoption of the proposed system of Airline Engineering and Maintenance Organization would afford the following advantages:

1. Reduced operation costs and investment charges.
2. The establishment of more efficient maintenance and overhaul systems, resulting in increased flight utilization.
3. A thorough and efficient program to promote safety.
4. Expanded engineering and research activities designed to improve transportation services in general.

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APPENDIX A

THE MASTER CONTROL CHART

The Master Control Chart is a visual aircraft statistical system used by all control units. Through this system it is possible to control the disposition of all aircraft in an efficient manner. All maintenance and overhaul activities can be directed from the Master Control Charts. Each chart should include the following items:

1. Aircraft time, mileage and position record.
2. Aircraft condition record.
3. Aircraft master time chart.
4. Fuel and oil consumption record.
5. Flight discrepancies and failure record.
6. Mechanical delay record.
7. Engineering change control.
8. Unit control record.
9. Recurring failure record.
10. Unit overhaul record.

APPENDIX B

THE RAMP CONTROL SYSTEM

The Ramp Control System is used by all Terminal Maintenance Control Units to control all aircraft in the flight status. By the use of this system ground delays can be cut to a minimum, and all aircraft can be

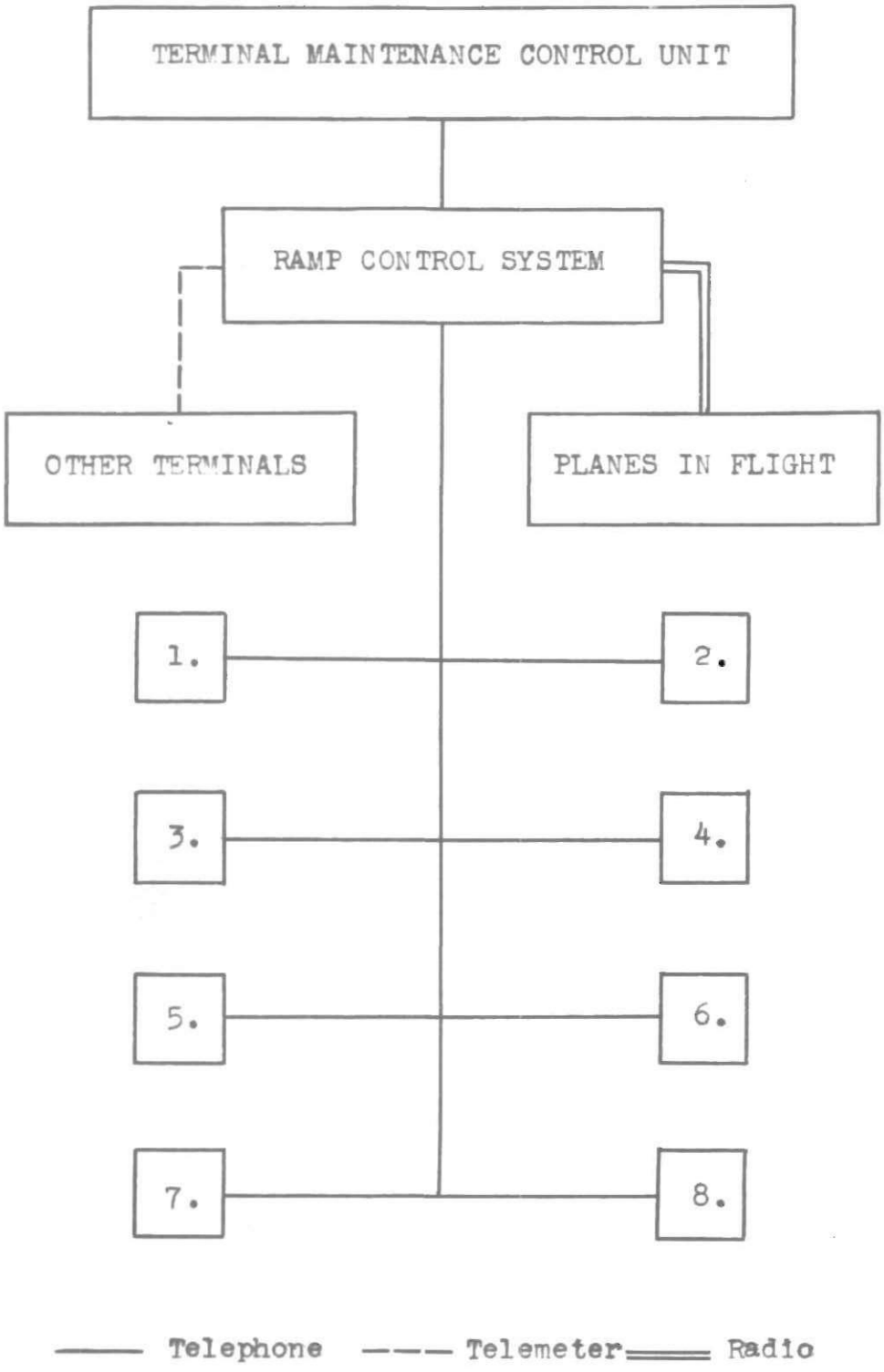

Figure 4.-Organization of the Ramp Control System.

dispatched in an efficient manner. The organization of the Ramp Control System is shown in Figure 4. Three means of communication are used. The work of a particular Ramp Control Unit is coordinated with that of other terminal units through telemeter connections. Planes in flight are contacted by radio, and the following facilities (shown by numbers in Figure 4) are reached by telephone:

1. Passenger Service
2. Operations
3. Reservations
4. Air Cargo
5. Line Maintenance
6. Flight Dispatch
7. Cabin Services
8. Commissary

APPENDIX C

LIST OF PERSONS INTERVIEWED DURING THE SURVEY

Mr. H. E. Wechmiller, Aircraft Consulting Service, 402 Hibbs Building, Washington 5, D. C.

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Mr. H. D. Estey, Superintendent of the Overhaul Division, P.C.A., The Capital Airline, Washington National Airport, Washington, D. C.